Primary Tweeters: Segmented Micro-Mirrors for Picometer-Scale Wavefront Compensation in Space-Based Observatories, Phase I

Completed Technology Project (2018 - 2019)

Project Introduction

The proposed innovation is a segmented, micromachined deformable mirror (DM) that can compensate tip-tilt-piston (TTP) positioning and stability errors of a segmented space-based primary mirror. This effort responds directly to the NASA FY2018 SBIR/STTR General Solicitation, Focus Area 10: Advanced Telescope Technologies, Subtopic S2.01: Proximity Glare Suppression for Astronomical Direct Detection. This subtopic focuses on new technological developments that are needed for exoplanet direct imaging, and specifically identifies wavefront measurement and control technologies as a key need. The core subject of this proposal is to develop a technology that is identified as critical in this subtopic: small-stroke, high-precision deformable mirrors and associated driving electronics. The solicitation specifically calls for a "Deformable, calibrated, collimating source to simulate the telescope front end of a coronagraph undergoing thermal deformations." The proposed DM would have complementary uses for both simulating the front end of a coronagraph (as a surrogate for its primary) and precisely compensating wavefront errors in the front end of an actual coronagraph. High-precision deformable mirrors have applications relative to multiple NASA needs. Commercialization opportunities in astronomy and space science include both space telescopes such as the Large UV/Optical/Infrared Surveyor (LUVOIR) and Habitable Exoplanet Imaging Mission (HabEx) telescopes. The DM architectures to be developed in this project also have commercial applications in non-government markets, including space surveillance and biological microscopy. In the microscopy market especially, the TTP DM has become a commercial product used in two photon nonlinear microscopes through the pioneering efforts of Na Ji at Howard Hughes Medical Insitute's Janelia Research Campus.

Anticipated Benefits

High-actuator-count deformable mirrors (DMs) have a few NASA applications. The following applications apply to all BMC DMs that benefit from processes developed for this program.

Astronomy: For space telescopes, a number of missions require the control provided by the proposed DMs such as LUVOIR and HabEx. For ground-based telescopes, BMC has successfully developed arrays up to 4096 elements for GPI and other high contrast imaging testbeds and can achieve similar results for other new ELTs.

The deformable mirrors (DMs) developed in this project have a few commercial applications and apply to all BMC DMs benefitting from processes developed for this program.

Space surveillance and optical comms would benefit from this new architecture for long-range imaging and secure communication. Microscopy Users would benefit in modalities such as multi-photon, 4Pi and localization microscopy. Finally, DM arrays will enable new techniques for laser marking, material

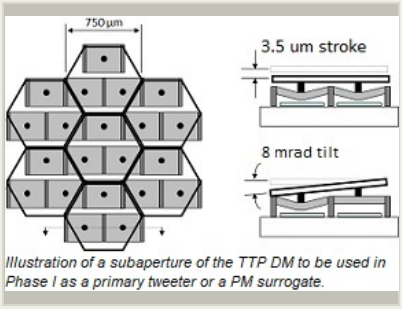

Illustration of a subaperture of the TTP DM to be used in Phase I as a primary tweeter or a PM surrogate.

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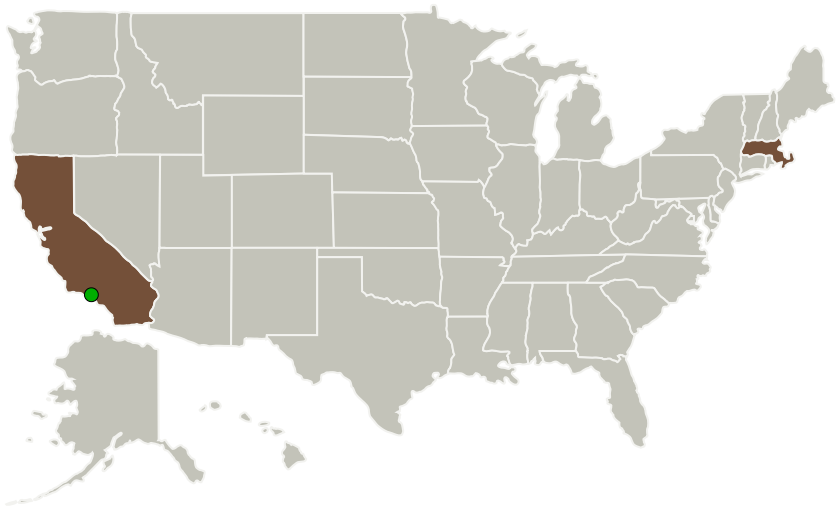
ablation and characterization.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Boston Micromachines Corporation	Lead Organization	Industry	Cambridge, Massachusetts
Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations	
California	Massachusetts

Project Transitions

July 2018: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Boston Micromachines Corporation

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Steven A Cornelissen

Co-Investigator:

Steven Cornelissen

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February 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/141240)*

Images

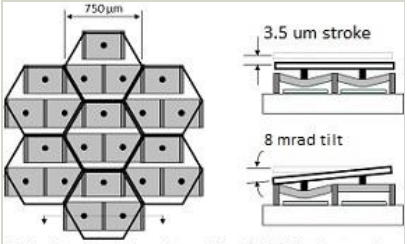
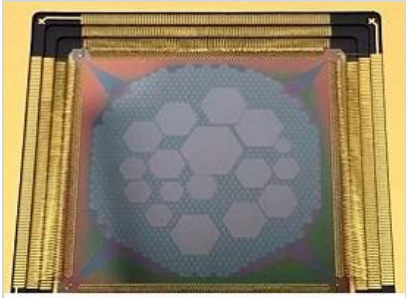


Illustration of a subaperture of the TTP DM to be used in Phase I as a primary tweeter or a PM surrogate.

Briefing Chart Image
Primary Tweeters: Segmented Micro-Mirrors for Picometer-Scale Wavefront Compensation in Space-Based Observatories, Phase I *(https://techport.nasa.gov/image/136681)*

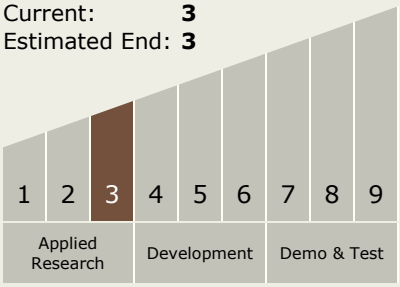


Packaged DM device containing multiple prototype designs for primary tweeter segments

Final Summary Chart Image
Primary Tweeters: Segmented Micro-Mirrors for Picometer-Scale Wavefront Compensation in Space-Based Observatories, Phase I *(https://techport.nasa.gov/image/129937)*

Technology Maturity (TRL)

Start: **3**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.2 Observatories
    - TX08.2.1 Mirror Systems

Target Destinations

Earth, Outside the Solar System